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(54) Rotary contact assembly for high ampere-rated circuit breakers

(57) A circuit breaker rotary arm (26) for movable contacts (29,30) is used within a plurality of single pole circuit breakers (11, 12, 13) ganged together to form a single multi-pole circuit breaker (10). To provide uniform contact wear among the associated circuit breaker contacts (27, 28, 29, 30), a rotor (25) carrying a pivot (39) of the rotary contact arm (26) is slotted to automatically position the rotary arm (26) supporting the movable contacts (29, 30) to allow for changes in the geometry of the contacts (27, 28, 29, 30) while maintaining constant contact compressive forces. The individual circuit breakers (11, 12, 13) connect with the central operation mechanism (18) by means of a single pin (38).

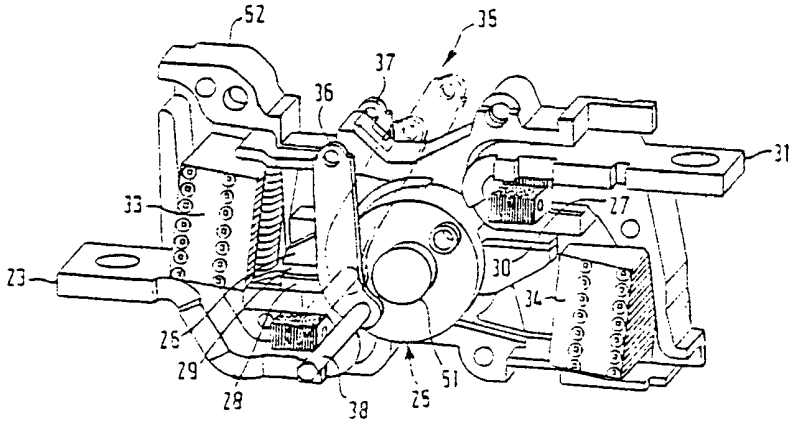

FIG. 2

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Description

The present invention relates to switching assemblies to be employed, in number of one or more, in low voltage industrial circuit breakers, specifically in molded case circuit breakers.

US Patent 4,816,198 entitled "Contact arrangement for a Current Limiting Circuit Breaker" describes the early use of a first and second pair of circuit breaker contacts arranged in series to substantially reduce the amount of current let-through upon the occurrence of an overcurrent condition.

When the contact pairs are arranged upon one movable contact arm, such as described within US Patent 4,910,485 entitled "Multiple Circuit Breaker with Double Break rotary Contact" some means must be provided to insure that the opposing contact pairs exhibit the same contact pressure to reduce contact wear and erosion.

One arrangement for providing uniform contact wear is described within US Patent 4,849,247 entitled "Contact Assembly for Low-voltage Circuit Breakers with a Two-Arm Contact Lever". This arrangement includes an elongated slot formed perpendicular to the contact travel to provide uniform contact closure force on both pairs of contacts.

US Patent 5,030,804 entitled "Contact Arrangement for Electrical Switching Devices" describes providing a pair of cylindrical plates on either side of the rotary contact arms and forming elongated slots within each of the cylindrical plates.

When the rotary contacts are used within a range of differing ampere-rated circuit breakers, the size of the contact varies in accordance with the ampere rating such that the accompanying cylindrical plates must be sized accordingly.

It would be economically advantageous to have a wide range of rotary contact circuit breakers having provision for reducing contact wear without having to stock and assemble a wide range of slotted cylindrical plates.

Accordingly, one purpose of the invention is to include means for reducing such contact wear in rotary contact circuit breakers over a wide range of ampere ratings with the smallest number of associated assembly components.

A circuit breaker rotary contact arm is used within a plurality of single pole circuit breakers ganged together to form a single multi-pole circuit breaker. To provide uniform contact wear among the associated circuit breaker contacts, the rotor carrying the rotary contact arm pivot is slotted to allow the contact arm to provide constant contact compressive forces. The central section of the contact arm is configured to position the contacts within defined CLOSED, BLOW OPEN (open by electrodynamic repulsion due, for example to a short circuit current) and LOCK OPEN positions. Interconnection of the rotor assemblies with the operating mechanism is achieved by a single elongated pin.

The features of the invention will be specifically defined in the appended claims. However, other features and advantages will result apparent from the following detailed disclosure of an embodiment thereof, depicted in the enclosed drawings, in which:

Figure 1 is a top perspective view of a multi-pole circuit breaker consisting of three single pole assemblies contained within a single circuit breaker housing;

Figure 2 is an enlarged side view of one of the single pole assemblies within the circuit breaker of figure 1;

Figure 3 is a top perspective view of the contact arrangement within the single pole assembly of Figure 2;

Figure 4 is a side plan view (turned upside down with respect to Figures 2 and 3) of the rotor used with the contact arrangement of Figure 2; and

Figure 5A is a side plan view of the single pole assembly of Figure 2 depicting the contact arm in the CLOSED position;

Figure 5B is a side plan view of the single pole assembly of Figure 2 depicting the contact arm in the BLOW OPEN position (under intense overcurrent condition, short circuit current);

Figure 5C is a side plan view of the single pole assembly of Figure 2 depicting the contact arm in the LOCK OPEN position; and

Figure 5D is a side plan view of the single pole assembly of Figure 2 depicting the contact arm in the DEFINITIVELY OPEN position due to the intervention of tripping devices associated to the circuit breaker.

A multi-pole circuit breaker is shown in figure 1 consisting of a case 14 and cover 15 with an operating handle 16 projecting from the cover through an aperture 17. The operating handle interacts with the circuit breaker operating mechanism 18 to control the ON and OFF positions of the central contact arm 26 and central rotary contact assembly 32 (Fig. 2) within the circuit breaker operating mechanism. A first rotary contact arm 22 and first rotary contact arm assembly 20 within a first pole 12, on one side of the operating mechanism 18, and a second rotary contact arm 24 and second rotary contact arm assembly 21 within a second pole 10, on the opposite side of the operating mechanism move in unison to provide complete multi pole circuit interruption. An elongated pin 38 interconnects the operating mechanism 18 with the first and second rotary contact arm assemblies 20, 21. As described within the aforementioned US Patent 4,849,247, a rotor 25 (Fig. 2) interconnects each of the rotary contact arms 22, 24 with the corresponding pairs of fixed contacts 27, 28 and movable contacts 29, 30.

In accordance with the invention, the central rotary contact assembly 32 is depicted in Figure 2 to show the

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positional arrangement between the rotor 25 intermediate a lower strap 23 and an upper strap 31 and the associated arc chutes 33, 34. The first rotary contact arm assembly 20 and the second rotary contact arm assembly 21 of figure 1 are not shown herein but are mirror images of the central rotary contact arm assembly 32 and operate in a similar manner. The arc chutes 33, 34 are similar to that described within US Patent 4 375,021 entitled "Rapid Electric Arc Extinguishing Assembly in Circuit-Breaking Devices such as Electric Circuit Breakers". The central rotary contact arm 26 moves in unison with the rotor 25 that, in turn, connects with the circuit breaker operating mechanism by means of the elongated pin 36 to move the movable contacts 29, 30 between the CLOSED position depicted in solid lines and the OPEN position depicted in phantom. The clevis 35 consisting of the extending side arms 36, 37 attach the rotor 25 with the circuit breaker operating mechanism 18 and the operating handle 16 of figure 1 to allow both automatic as well as manual intervention for opening and closing the circuit breaker contacts 27-30. The rotor 25 is supported within side walls 52 by means of trunnion 51.

The rotor 25 is shown in Figure 3 along with the central rotary contact arm 26 positioned between the lower and the upper straps 23, 31 along with one of the contact pairs 28, 29 to show the arrangement of a pair of contact closing springs 41, 42 on opposite sides of the rotor 25 to hold the contacts in close abutment to promote electrical transfer during quiescent circuit current conditions. The operating pivot pin 39 of the central rotary contact arm 26 extends through the rotor 25 and responds to the rotational movement of the rotor to effect the contact closing and opening function. The central region 26A of the central rotary contact arm 26 is positioned within an elongated slot 40 formed within the rotor 25, one side of which is removed to more clearly depict the top and bottom pins 43, 44 that extend across the associated top and bottom rollers 45, 46 to avoid uneven wear of the central region 26A. The positional relationship between the rollers 45, 46 to avoid uneven wear of the central region 26A of the rotor 25 is an important feature of the invention and will be described below with reference to figures 5A-5D.

The rotor 25 is shown in Figure 4 which is turned upside down with respect to Figures 2 and 3) relative to the lower strap 23 and upper strap 31, the central contact arm 26 and contacts 27-30 to help in describing the manner in which the fixed contacts 27, 28 remain in closed abutment with the movable contacts 29, 30 in counter-relation to contact erosion and wear. As shown earlier, a pair of extension springs, one of which is shown at 42, extend between opposing top and bottom pins 43, 44 that are positioned within the elongated slots 53 and 54 in the rotor 25. An elongated aperture 47 is formed through the rotor 25 and the operating pivot pin 39 that connects the rotary contact arm 26 with the rotor extending through the elongated aperture. The "floating" relationship between the operating pivot pin 39 and the contact closing springs 41, 42 allows the springs to force the movable contacts 29, 30 into tight abutment with the associated fixed contacts 27, 28, as indicated in phantom, to compensate for contact wear and erosion.

The enhanced contact separation and control provided by the rotor 25 is best seen by now referring to Figures 5A-5D wherein the top and bottom rollers 45, 46 remain rotationally immobile relative to the pivot pin 39 of the central rotary contact arm 26 while the contacts 27, 30 move from the CLOSED, to BLOW OPEN, to LOCK OPEN and DEFINITIVELY OPEN positions indicated therein. Although the effect of the rotation of the central rotary contact arm 26 is the same for the contacts at both ends, the contact descriptions for the contacts 28, 29 opposite from the contacts 27, 30 are omitted for purposes of clarity. The central region 26A of the central rotary contact arm 26 operating within the elongated rotor slot 40, is such that the top roller 45 aligns with one end of a first camming surface 48 formed on the top of the central section. A similar profile exists for the central section 26A in the vicinity of the bottom roller 46 to control the contacts on the side of the central rotary contact arm 26 opposite from the contacts 27, 30. In the CLOSED condition indicated in Figure 5A, the line of force created by springs 41, 42 and through the roller 45 and central rotary contact arm 26 is indicated by the arrow A. In the BLOW OPEN condition, when the central rotary contact arm 26 is magnetically "blown" in the counter-clockwise direction under intense overcurrent conditions, the roller becomes tracked on the second camming surface 49 formed on the central region as indicated in Figure 5B. During the BLOWN OPEN condition, the line of force created by springs 41, 42 and through the roller 45 and central rotary contact arm 26 is indicated by the arrow B. The line of force B, which controls the opening of the central rotary contact arm 26 under an intense overcurrent condition, is dictated by the shape of the second camming surface 49. Devices suited for selectivity will employ a second camming surface 49 that produces a line of force B1. Whereas, devices suited for rapid opening will employ a second camming surface 49 that produces a line of force B2. Upon complete contact separation by further rotation of the rotary contact arm 26 in the counter-clockwise direction to the LOCK OPEN condition shown in Figure 5C, the roller 45 becomes tracked within the groove 50 formed on the central region on the opposite side of the second camming surface 49 from that of the first camming surface 48. In the LOCK OPEN condition, the line of force created by springs 41, 42 and through the roller 45 and central rotary contact arm 26 is indicated by the arrow C to prevent the central rotary contact arm 26 from rotating back to the CLOSED condition. Tripping of the circuit breaker operating mechanism with central rotary contact arm 26 in the LOCK OPEN condition causes the rotor 25 and the rollers 45, 46 to rotate in a counter-

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clockwise direction until the rollers 45, 46 engage the camming surface 48, placing the central rotary contact arm 26 in the OPEN condition. The central rotary contact arm 26 remains in the OPEN condition, depicted in Figure 5D, until the operating handle 16, described earlier in Figure 1, is first rotated to the contact opening to reset the operating mechanism, and then to contact closure, as viewed in Figure 1, to reset the operating mechanism and return the rotary contact arm to the CLOSED condition shown in Figure 5A.

A rotary contact arm assembly for circuit breaker having a wide range of ampere ratings has herein been described. Contact wear and erosion along with rotary contact arm control facility and mechanism interconnect means was illustrated by use of a limited number of components to reduce component cost as well as assembly time.

Claims

1. A circuit breaker comprising an electrically-insulative case (14) and cover (16), first and second pairs of separable (28, 29; 30, 27) contacts within said case (14) and arranged for connection with an electrical circuit, said first pair of contacts (28, 29) being arranged at one end of a first rotary contact arm (26) and said second pair of contacts (30, 27) being arranged at an opposite end thereof, an operating mechanism (19) within said case (14) interacting with said first rotary contact arm (26) to rotate first rotary contact arm (26) and interrupt said electric circuit upon occurrence of an overcurrent condition; characterized by:

   a first rotor (25) connecting said first rotary contact arm (26) with said operating mechanism (19), said first rotor (25) having an elongated slot (40) and said first rotary contact arm (26) having a first pivot pin (39), whereby said first pivot pin (39) extends through said elongated slot (40) for providing clearance between said pivot pin (39) and said first rotor (25).

2. The circuit breaker of claim 1, characterized by third and fourth pairs of separable contacts within said case (14) and arranged for connection with said electrical circuit, said third pair of contacts being arranged at one end of a second rotary contact arm (22) and said fourth pair of contacts being arranged at an opposite end thereof.

3. The circuit breaker of claim 2, characterized by fifth and sixth pairs of separable contacts within said case (14) and arranged for connection with said electrical circuit, said fifth pair of contacts being arranged at one end of a third rotary contact arm (24) and said sixth pair of contacts being arranged at an opposite end thereof.

4. The circuit breaker of claim 1 characterized in that said first rotary contact arm (26) comprises a first central region (26A) perimetric to said first pivot pin (39), said first central region (26A) defining a first camming surface (48) for holding said first rotary contact arm (26) in a closed position.

5. The circuit breaker of claim 4 characterized in that said first central region (26A) further defines a second camming surface (49) for controlling the transition of said first rotary contact arm (26) to a blow open position.

6. The circuit breaker of claim 5 characterized in that said second camming surface (49) on said first contact arm (26) has a line of force (B) through the centre of rotation of said first contact arm (26).

7. The circuit breaker of claim 5 characterized in that said second camming surface (49) on said first contact arm (26) has a line of force (A) biasing said first contact arm (26) in a clockwise direction.

8. The circuit breaker of claim 5 characterized in that said second camming surface (49) on said first contact arm (26) has a line of force (C) biasing said first contact arm (26) in a counter-clockwise direction.

9. The circuit breaker of claim 5 characterized in that said first central region (26A) further defines a recess (50) for holding said first rotary contact arm (26) in a lock open position.

10. The circuit breaker of claim 6 characterized in that said rotor (25) includes a second elongated slot on an opposite side thereof.

11. The circuit breaker of claim 10 characterized in that said rotor (25) includes a pair of extension springs (41, 42), one on each side, said extension springs (41, 42) extending between a pair of first and second pins (43, 44) extending from said both sides of said rotor (25).

12. The circuit breaker of claim 11 characterized by including a pair of first and second rollers (45, 46) arranged over said first and second pins (43, 44), said first and second rollers (45, 46) entrapping said first central region (26A) therebetween.

13. The circuit breaker of claim 12 characterized in that said first and second rollers (45, 46) interact with said first and second camming surfaces (48, 49) on said first central region (26A) to position said first rotary contact arm (26) in said closed and said blow open positions.

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14. The circuit breaker of claim 13 characterized in that said first and second rollers (45, 46) interact with said recess (50) on said first central region (26A) to position said first rotary contact arm (26) in said lock open position.

15. The circuit breaker of claim 10 characterized in that said first central region (26A) is positioned within said elongated slot (40).

16. The circuit breaker of any one of claims 1 to 3 characterized in that said rotor (25) is connected with said operating mechanism (18) by means of an elongated pin (38).

17. The circuit breaker of claim 1 characterized in that said rotor (25) is supported in said case (14) and cover (15) by a trunnion (51).

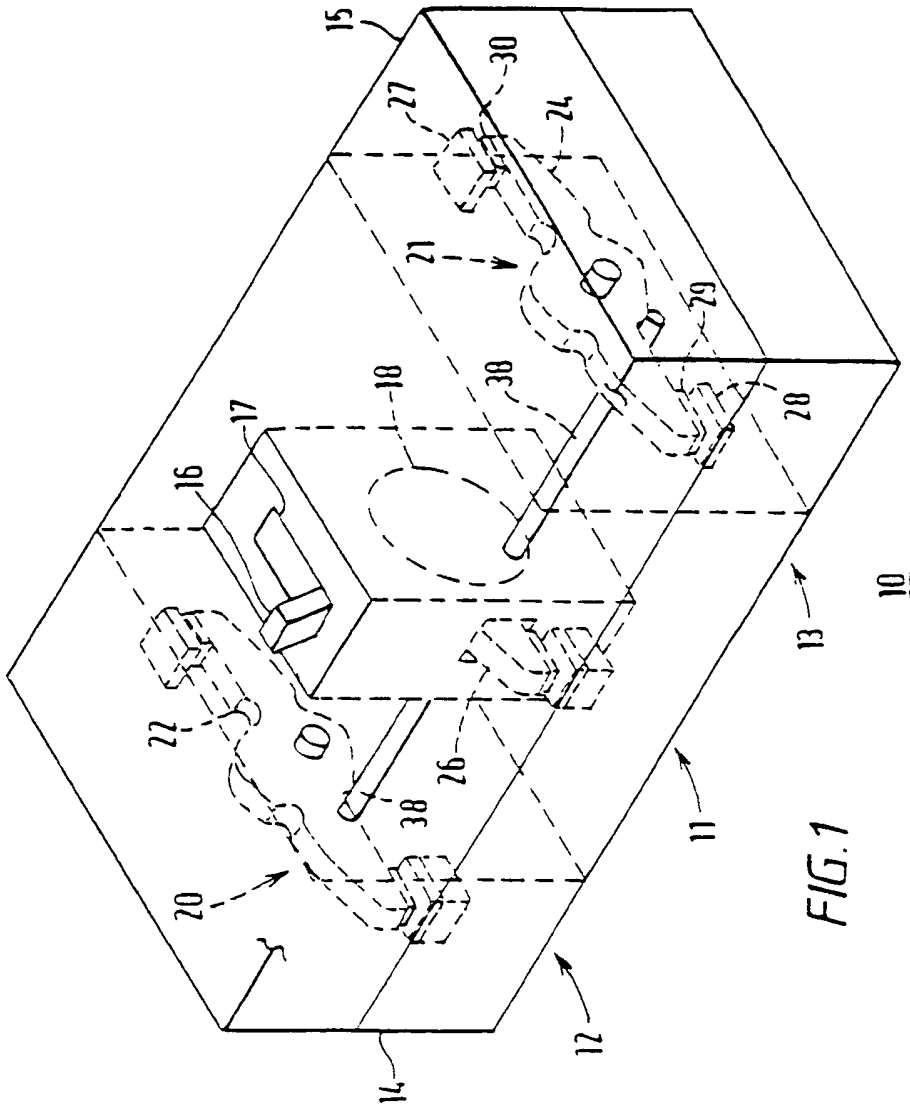

FIG. 1

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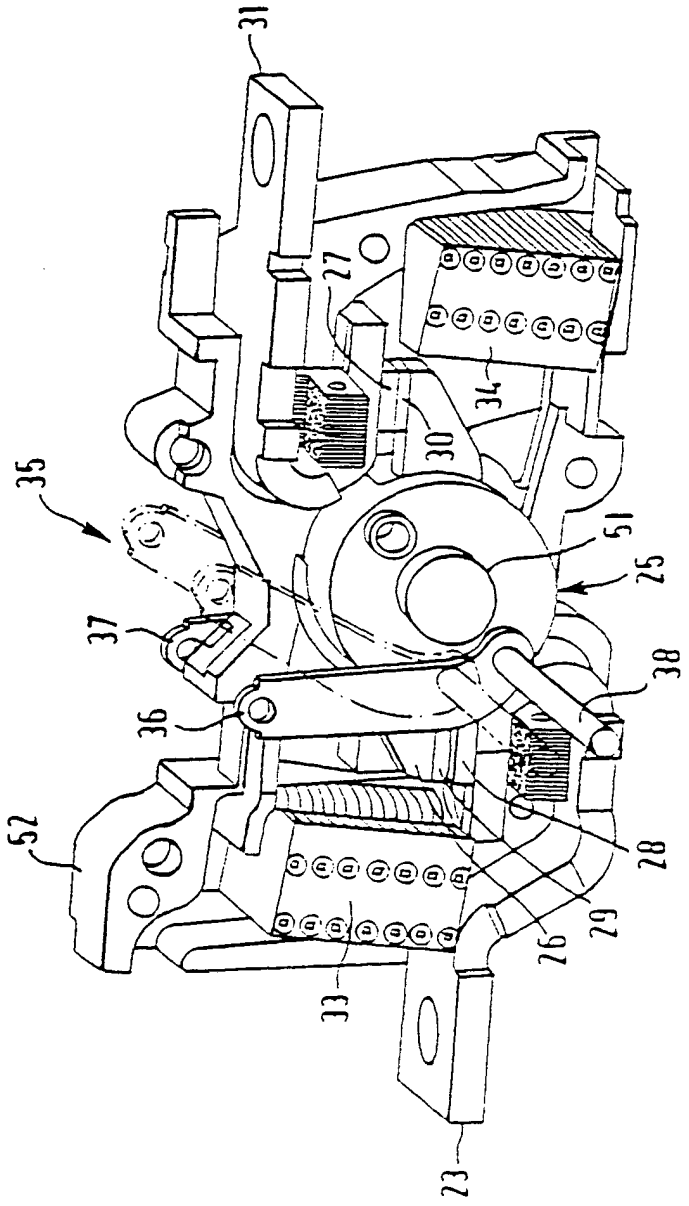

FIG.2

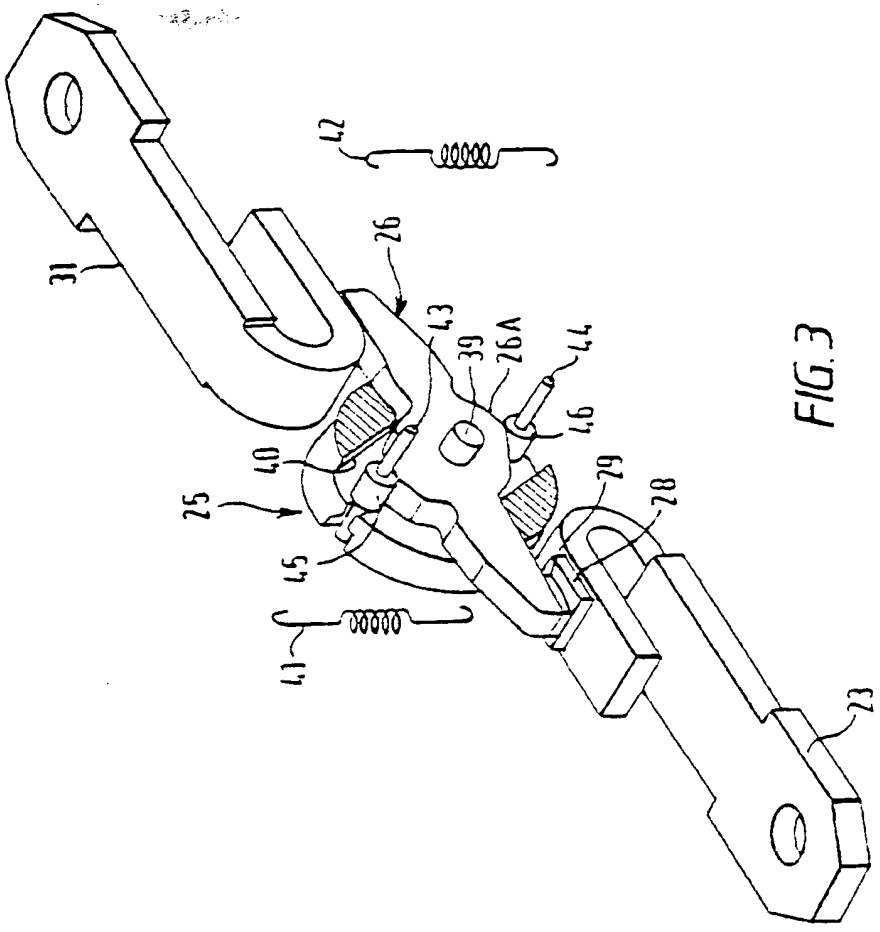

FIG. 3

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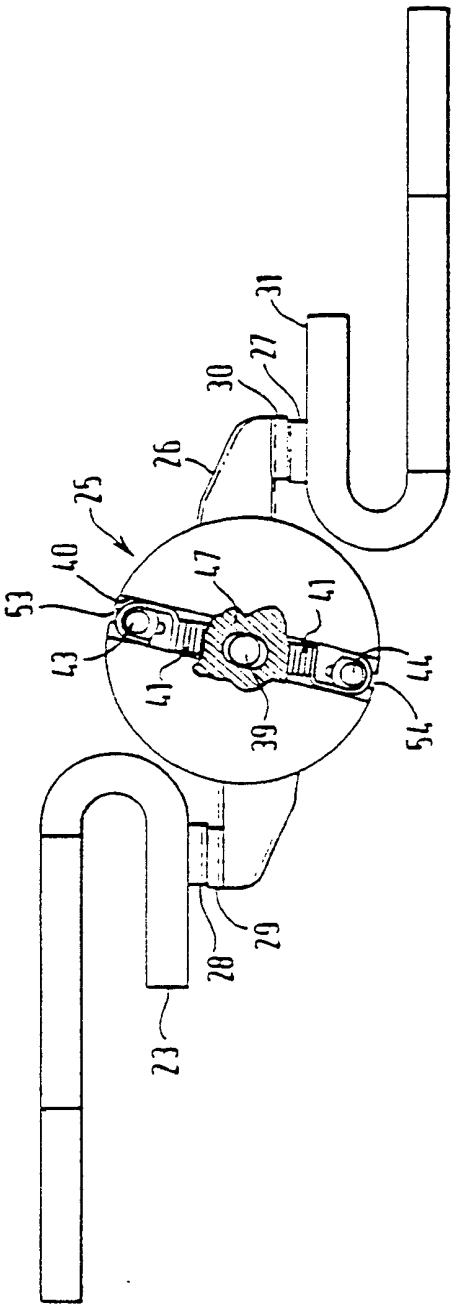

FIG. 4

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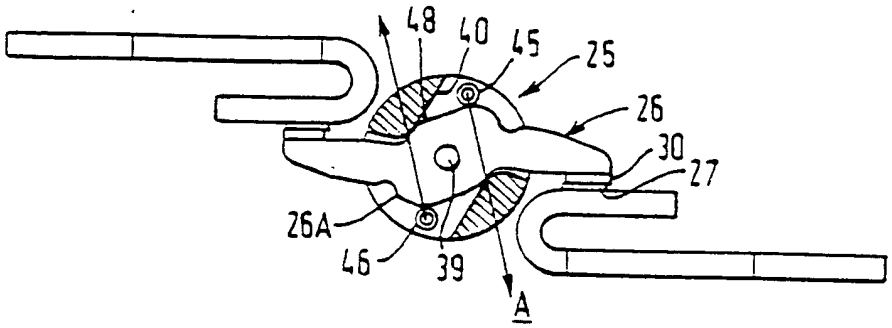

FIG.5A

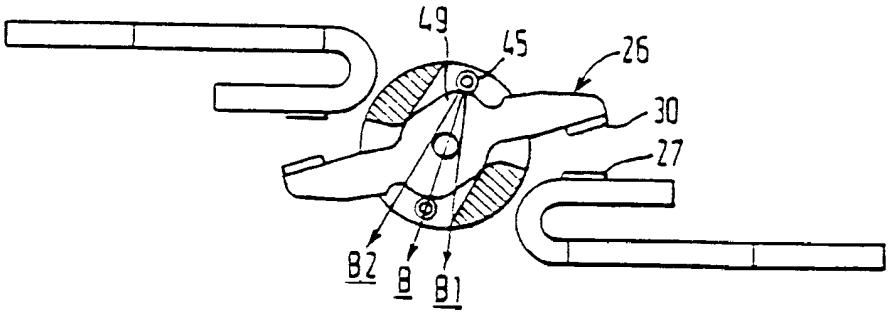

FIG.5B

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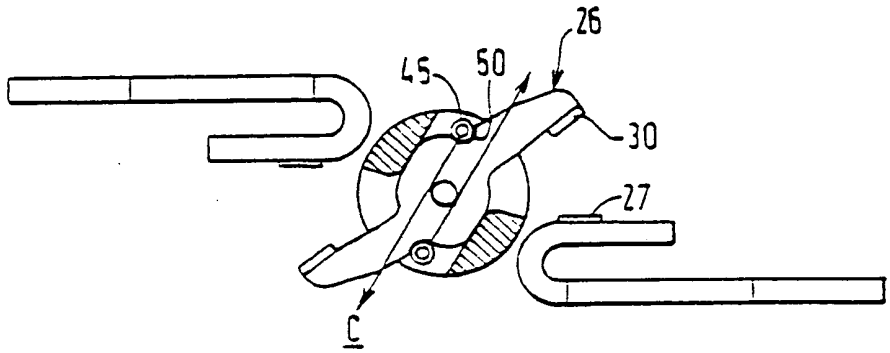

FIG. 5C

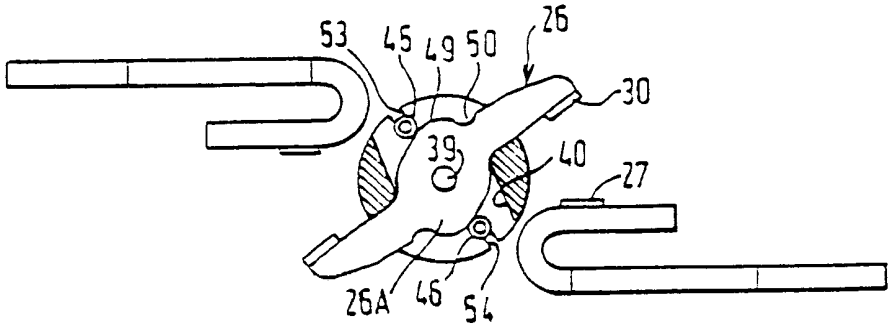

FIG. 5D

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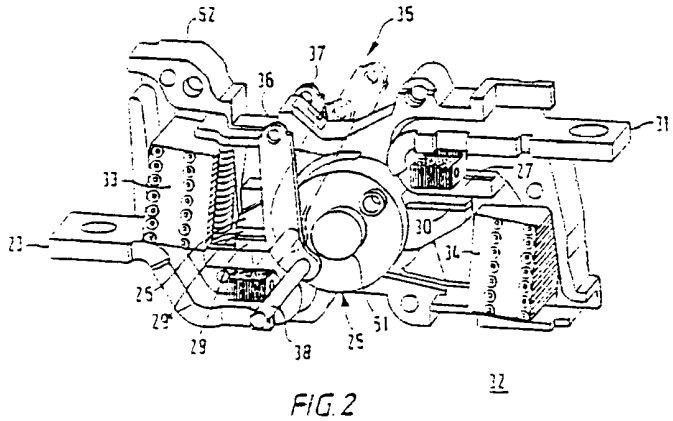

FIG. 2

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EUROPEAN SEARCH REPORT

Application Number
EP 98 30 5207

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TECHNICAL FIELDS SEARCHED (Int.Cl.6)

H01H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	28 April 1999	Janssens De Vroom, P

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